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GRAVEL AS A RESISTANT ROCK[1]

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In a recent[2] number of the *Journal of Geology*, Mr. John L. Rich presents the thesis that "gravel, in its relation to the agencies of denudation, is under certain geological conditions a highly resistant rock. To these agencies it will, in general, offer greater resistance than ordinary igneous or sedimentary rocks, with a few possible exceptions."[3]

The writer is in accord with this general thesis; but the specific evidence presented in arriving at this conclusion is not wholly accurate, and certain deductions affecting the physiographic history of the region should in the writer's opinion be interpreted differently.

Mr. Rich divides his paper into three parts: (1) to point out the theoretical reasons for the resistant nature of gravel deposits; (2) to show, from an actual occurrence in nature, that the gravels do behave as the theoretical considerations would lead us to expect; and (3) to sketch by way of suggestion the normal course of development of topography in a region where alluvial fans of coarse material are accumulating at the base of mountains. It is especially with No. 2 that the following has to deal.

It is shown that a plain-like lowland lies between the northern edge of the gravel deposits and the high mountains to the north. This lowland is in places 100 feet below the base of the gravel south of it, and is crossed by the mountain streams flowing southward out upon the desert deposits.

To explain this feature Mr. Rich presents three alternative hypotheses: (1) The gravels may have been removed by erosion from the area between their present limit and the mountains; (2) There may have been faulting by which the lowland was relatively lowered; or (3) The mountains may have been worn back and the lowland developed by differential erosion since the deposition of the gravel.

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[1] *Jour. Geol.*, XIX, No. 6.

[2] *Op. cit.*, p. 492.

[3] Published by permission of the Director of the U.S. Geological Survey.

Mr. Rich adopts the latter explanation and presents evidence to show that No. 1 is impossible. I wish first to indicate wherein the statements used as evidence to disprove No. 1 are inaccurate, and second to show that a combination of No. 1 and a part of No. 2 is the more plausible explanation of the observed facts.

Mr. Rich says:

> Opposed to the first of these alternatives is the fact that the gravel plateau ends abruptly along a relatively straight line. There are no outliers of gravel between this general line and the mountains. It is highly improbable that streams flowing nearly parallel and not more than a mile apart should strip all signs of the gravels from the upper four miles of their course, while in their lower course, where they flow across the gravel plateau, they should be in relatively narrow valleys with almost no tributaries and should have done little more than to cut their way through the plateau without having been able to widen their valleys to any great extent (Fig. 2).
>
> A second objection is the fact that the line of contact between the gravels and the underlying rock slopes upward toward the mountains at such an angle that it would intersect the projected line of the plateau surface at a point not far within the present limit of the gravels (see Fig. 5). In other words, the gravels thin toward the mountains at such a rate that they would wedge out within a short distance from their present limit, and the lowland is accordingly developed in the bed-rock.

On that portion of the geologic map of the Silver City quadrangle shown by Mr. Rich two important outliers have been omitted. Their position is shown in Fig. 1, *a* and *b*. Still another outlier is present at *c*, which position was just off the western edge of the first map. Nor should it be said that the gravel plateau ends abruptly along a relatively straight line, for as shown on the map the edge of the gravel plain has many of the characteristics of an erosion border. Further, it is not "highly improbable" that streams flowing nearly parallel and not more than a mile apart should strip all signs of the gravels from the upper four miles of their course, for a point which has failed to be considered here, though it is mentioned in another place (p. 500, line 3), is that *an increased* *gradient near the mountain core* probably existed; first, because such an increased gradient is normal, and second, because there is in this entire region strong evidence of post-Pleistocene tilting (due to faulting) in the north.

Next, the diagram, Fig. 5[1] (used as evidence in the argument that the gravels never extended farther mountainward), is misleading. By actual outcrop on the map it may be shown that the gradient of the gravel *base*, measured from a *ridge top* to a *valley bottom* (the most favorable measurement), in places does not exceed 200 feet to the mile. The diagram shows a gradient of 1,500= feet to the mile. The long thin outlier north of Silver City has a basal gradient approximating 100 feet to the mile. The outlier on the extreme west has apparently a still lower gradient. The diagram is misleading because, with the low gradient that is shown above to exist, and with a gravel plain the top of which has an increasing gradient, the gravel might well have extended farther mountainward.

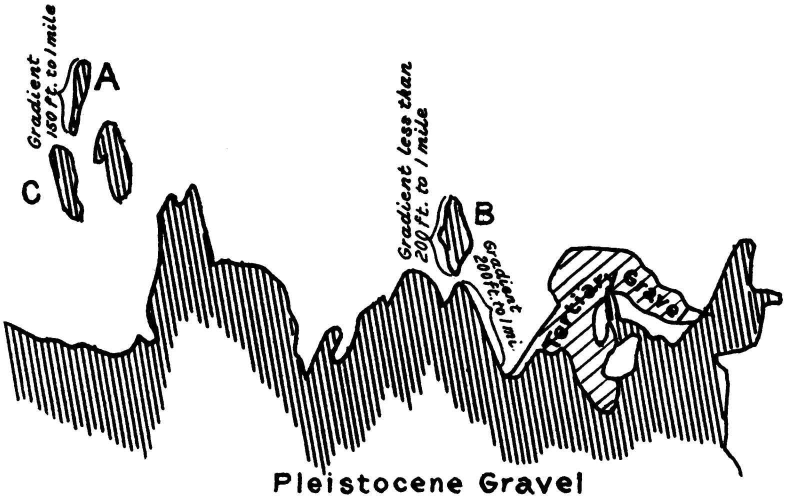
Gradient 150 ft. to 1 mile
A
C
Gradient less than 200 ft. to 1 mile
B
Gradient 200 ft. to 1 mi.
Tertiary Grave
Pleistocene Gravel

FIG. 1.—Showing irregular edge of gravel sheet and outliers north of it

Further to cast doubt on the hypothesis that the mountain front once stood at the present position of the gravel edge and that the gravels did not extend farther northward, the following facts are submitted. The lava series (composed of igneous sheets and interbedded gravel deposits at each locality of essentially the same character) is found north, northwest, northeast, southeast, and southwest of this area. A deposit of gravel belonging to this series actually underlies the Pleistocene gravel at the eastern side of the map (see Fig. 1). Besides these facts there is clear structural evidence, which need not be considered here, which leads to the inference that great lava sheets once *covered* this entire area, and that the gravel which now occupies this space at the surface is the dêbris derived from the denudation of the great up-faulted portions of these sheets, of which such masses as the Little Burro Mountains, Lone Mountain, and the Silver City Range are the remnants. From this it is logical to conclude that the present frayed northern edge of the gravels occupies its position, not because it represents an old scarp line, but because it represents a position of stability established by a number of factors—gradient, rainfall, favorable location with respect to drainage, etc.—all acting on a gravel sheet which originally extended farther northward. After the edge was eroded back to this position of stability, it is conceivable—in fact, is probable—that differential erosion carved out the lowland lying north of it.

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[1] *Op. cit.*, p. 501.

To sum up: The gravels have been removed by erosion from a portion of the area between their present limit and the present position of the mountains, and the lowland has been developed *in the old floor* upon which these gravels once rested, by differential erosion.